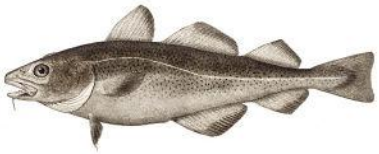
Schooner *Adventure*
Fish and Fishing Activity Packet

Investigating Reasons Why the Gulf of Maine is a Rich Fishing Ground.

Objectives:

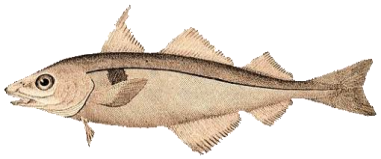
- Investigate why fish and the fishing industry are here.
- Investigate the life cycles, food chains/webs and the habitats of Atlantic cod, halibut and haddock.
- Investigate the New England fishing industry and how it has adapted to and changed the presence of the fish.

Who's Here? Fish!

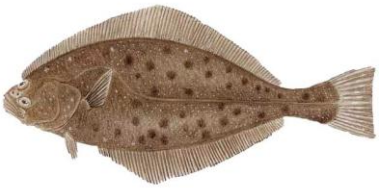


I. Investigating Habitat of Cod, Haddock and Halibut
   A. What are the ocean community levels and habitats?
   B. What are the habitats of 3 bottom dwelling fish – cod, haddock and halibut?
   C. How can you identify habitat conditions?

II. Investigating Life Cycle of Cod, Haddock and Halibut
   A. What do they need to survive?
   B. What are the stages of the life cycles?
   C. Can changes to habitat influence life cycle?



III. Investigating Food Chains and Food Webs
   A. What do they eat?
   A. Food chain vs. web – What the difference?
   B. How has human activity affected food webs?



I. Investigating Habitat of Cod, Haddock and Halibut

Materials:

- " Who Lives Where" WS
- "What's Down There" cards and sheets
- Cod, haddock and halibut fact sheets
- Catch map and Gulf of Maine landform map
- "Lead Lining" Lab
    - Lead lines
- "Sonar Mapping of the Ocean Floor" Lab
    - Ocean bottom shoebox
    - Sounding rods
    - Rulers
    - Graph paper and pencils
- "Exploring Ocean Features and Shoe Box Activity" Lab
- Hide-a-fish WS

Inquiry Questions and Objectives:

1. Where do we find these fish?
2. What are the habitat conditions in these locations?
3. How can you find out what the ocean bottom is like?

Activities:

1. Ocean community levels - Introduce ocean levels and habitats
    1. " Who Lives Where" WS – identify 3 community layers
        a. Plankton - organisms float, drift, swim near surface – consist of plants and animals (answers: 4 phyto- and zoo planktons)
        b. Nekton – animals that swim within the water column (answers: whale, fish)
        c. Benthos – organisms live on or in the bottom of the water column – consist of plants and animals (answers: crab, lobster, shellfish, sea plants and some fish)
    2. "What's Down There" Sort – match habitats, depths, and life forms

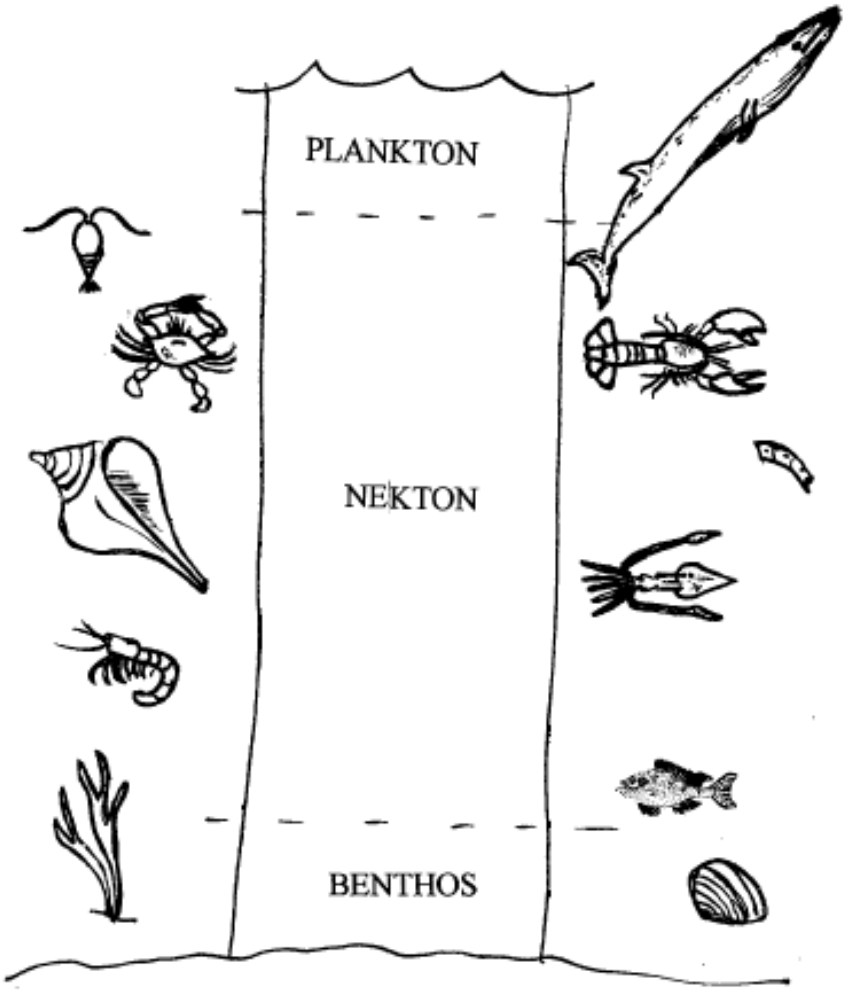
2. Introduce 3 bottom dwelling fish – cod, haddock and halibut
    1. Looking at body structure -
        a. What do they need to survive?
        b. Where do you think these fish live?
    2. Compare and contrast fish facts and habitats – cod, haddock and halibut fact sheets
        a. Where were these fish caught?
        b. What are the habitat conditions in these locations?
    3. Compare and contrast catch locations – catch map and Gulf of Maine landform map

4. Habitat conditions – methods to identify
    1. How can you tell what the ocean bottom is like?
    2. Sounding/Lead lining - Lead Lining Lab
    3. Sonic soundings/radar - Sonar Mapping the Ocean Floor

Extension – Hide –a-Fish

Who Lives Where

Life in the ocean ranges from submicroscopic plants to huge animals. Ocean life is generally divided into three major communities based on the habitat of the organisms and has nothing to do with their scientific classification, size, or complexity, or whether plant or animal. These three communities are: 1. plankton - these organisms float, drift, or feebly swim and consists of both plant and animal groups. 2. nekton - this community consists soley of animals. These animals swim within the water column. 3. benthos - these organisms live on or in the bottom of the water column. Match the organisms below in the side columns with the community they would be most likely to occupy as adults. Draw a line from the organism to the community level in the center.



9. WHAT'S DOWN THERE?

Concept: Living things are found almost everywhere on planet Earth.

Action: Students use *Habitat* game cards to figure out matching sets of area and creatures.

Grade Level: 2-6 adaptable.
Benchmarks: 2, 3, 7, 8, 9, 12.

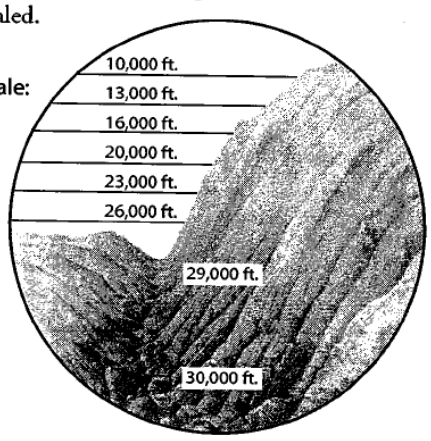
Standards: Teacher: A, B, C; Students K-4: D, E, G.

Background: Back in the days when people believed the Earth was flat, they also thought that the ocean bottom was a flat expanse a few hundred feet down. They believed that nothing, not even fish, could live in very deep water. In the mid-1800s a surprising event brought these claims into question. A section of the trans-Atlantic cable had to be lifted to the surface for repair, and it was encrusted with oysters and other sea life. The men were astonished!

> *Sounding* is the process of dropping a line and sinker into water to learn how deep it is.

This led to one discovery after another. Curious men took *soundings* to find out how deep the ocean water really is, and discovered the bottom is not flat, and is much deeper than people had believed. Another century passed before diving inventions made deep sea exploration possible. (See Lesson 8.) Over time, the rich variety of sea life at even the deepest parts of the ocean has been revealed.

Ocean depth scale:



> *Black Smokers* are rocky chimneys several feet high that form around hot water vents in mid-ocean ranges.

The most astonishing discovery is the many weird creatures that live around hot water vents in the deep, mid-ocean ridge areas. Instead of depending on photosynthesis and oxygen, tube worms, mussels, and clams feed on bacteria that have digested sulfur compounds thrown off by the hot vents. This process is called *chemosynthesis.* Even further down in deep ocean trenches 20,000-35,000 feet below sea level more living things are seen. Down that deep, darkness is complete, water pressure is extremely high, and there is no oxygen.

> *Bioluminescence* is the release of light without heat by living creatures.

At the other extreme of frigid cold, bacteria have been found living under ice hundreds of feet thick in the arctic regions. These bacteria can extract enough oxygen from the freezing air and water trapped under the ice to survive. All of these discoveries raise more questions for curious scientists.

Animals that live in the water take in oxygen dissolved in the water. Simple animals absorb the oxygen through their body surfaces. More complex animals, such as clams, filter water through their bodies and obtain oxygen as it flows thru. Advanced animals, such as fish, have gills. Then there are the deep-sea animals that depend on sulfur compounds for a process called *chemosynthesis* because there are no plants for photosynthesis and therefore no oxygen.

Land animals that live in extreme conditions include such creatures as polar bears in the Arctic, penguins in the Antarctic, and the reptiles and insects at home on the deserts. For this lesson we focus on the ocean because habitat change is so dramatic and so recently observed. Students are asked to use *Habitat* game cards

for clues to the different ocean communities and figure out matching sets of areas and creatures. Kids of all ages may find this to be an entertaining challenge!

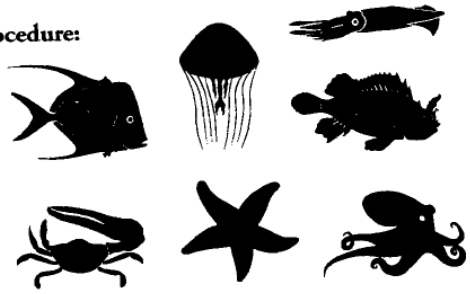
Materials: • Sets of *Habitat Game Cards*

Preparation: This activity can be adapted for younger or older students by using simpler cards only or using full sets. Read through the procedures and decide how to use them with your students.

A sea creature for the introduction may come from a fish market, or be borrowed from the biology department.

Make copies of the card sets you decide to use for each team of 3 students and shuffle each set of cards. You may want to save the cards for future classes. Copy them onto oak tag or similar stiffer material and/or laminate them.

Procedure:



1. To begin, draw a simple sketch of a fish, a seastar, and/or another sea creature on the blackboard. Ask students what they know about this creature, such as different places where they live, how they breathe, what they eat, etc. List what they think they know on the chalkboard under **K** (for what they know). Ask what else they want to know and list their questions under **W** (for want to know).

2. Have students work in teams of three. Depending on how you want to use the cards with your students, provide each team with a set of cards. For younger students you may want to use fewer sets or use cards in the HABITAT and DEPTH cards to begin, and introduce the LIFE FORMS cards after the teams have dealt with the first two sets. The challenge for the teams is to sort HABITAT, DEPTH, and LIFE FORMS cards into matched sets. For example, seashore habitat is at sea level and has life forms that can live in and/or out of water. As they work, ask students to write down any new questions they may have.

3. After teams have completed their sets, have them share their solutions with the class.

(A) Do teams agree on the make-up of the sets? If not, ask each team to explain why they placed certain cards together. Use background information to promote class discussion and guide students' thinking.

4. **(A)** Ask if students' questions on the chalkboard have been answered. Do they have new questions to add to the list? Students provide answers to be listed on the chalkboard under **L** (for what we learned). If some questions have not been answered, can students suggest ways to find out? You may want to refer them to resources such as the library or internet.

5. **(A)** Students create posters of habitat and life forms at an ocean depth of their own choosing.

Extensions:

The class visits an aquarium to see examples of ocean life and to ask questions of experts on the staff.

2. Tales of sea monsters have been around for thousands of years. Students investigate these mythical creatures and why they were so feared. Was there a real cause for the fear?

3. Students research marine plant life such as seaweeds, marsh grasses, and kelp forests. How do such plants cope with salt water?

References:

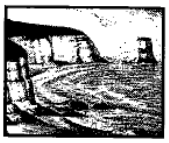
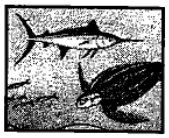
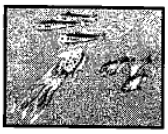
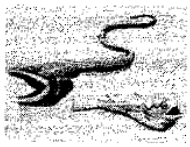
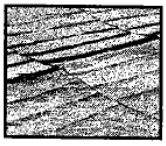
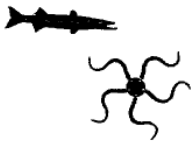
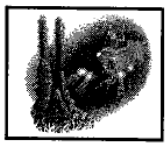
Burnie, David, et al, *Pocket Science Encyclopedia*, DK Publishing, Inc. London, England. 1998.

Harris, Nicholas, *Journey to the Depths of the Ocean*, Peter Bedrick Books, Lincolnwood, IL, 2000.

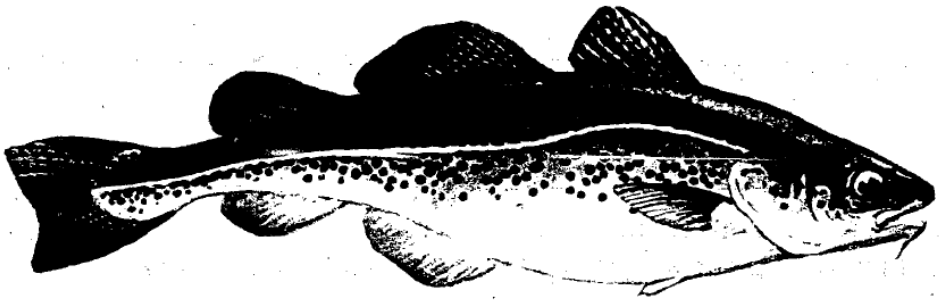
Parker, Steven, *Eyewitness Books: Fish*, DK Publishing, Inc., London, England, 2005

Sullivan, George, *To The Bottom of the Sea*, Twenty-first Century Books, Brookfield, CT, 1999.

HABITAT GAME CARDS

A. HABITAT CARDS	B. DEPTH CARDS	C. LIFE FORMS CARD
SEASHORE • Tidal zones • Animals in and out of the water with the tides 	SEA LEVEL	• Sea birds • Sea weeds • Barnacles • Worms • Crabs • Clams 
SURFACE WATERS • Sunlight and air • Water pressure 	to 650 feet	• Seals • Fish • Seaweed • Whales • Sharks • Sea birds 
TWIGHLIGHT ZONE • Little sunlight or air • More water pressure 	650-3300 feet	• Fish with sensitive eyes • Some fish can make light with special organs 
CONTINENTAL SLOPE • Cold, black depths • Deep canyons 	3300-16,000 feet	• Very little life • Fish have *bioluminescence* 
ABYSSAL PLAIN Rocky bottom covered with soft, muddy ooze 	13,000-16,000 feet	Plenty of animals feed on pieces of dead matter floating down from above 
MID-OCEAN RIDGE Mountain chain formed from hot lava from under-sea volcanoes 	Rises from Abyssal Plain	Animal life depends on height of ocean ridges 
HYDROTHERMAL VENTS Cracks in sea bed spurt very hot water – Black Smokers 	Rise from Mid-Ocean Ridge	Crabs, clams, lobsters, tubeworms, eelpout fish, that feed on sulfur-eating bacteria near Black Smokers 
DEEP OCEAN TRENCH Deepest part of ocean – flat bottom with cover of ooze 	20,000-35,000 feet	Animals with no air space in their bodies – certain forms of fish, worms, sea anemone and sea cucumber 

COD



Latin Name — Gadus morhua

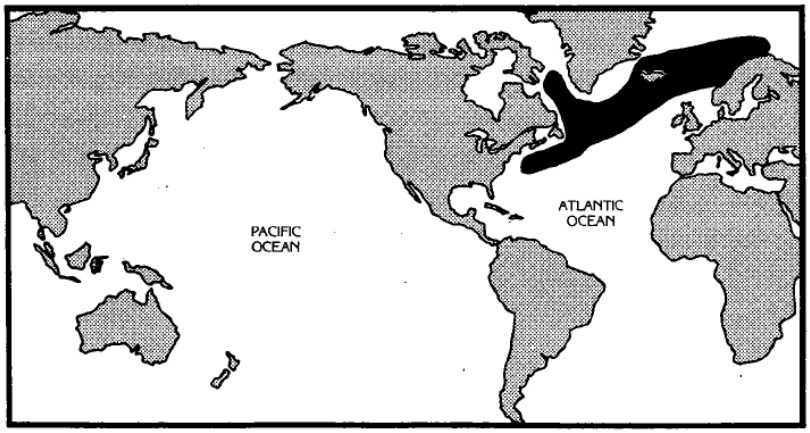
Also Known As — Atlantic cod or scrod (1½ lb. or less)

Description — Covered with round brown or red spots with a distinct light lateral line along the side, cod can change color to match its surroundings. Has protruding upper jaw, chin barbel and square tail. Can weigh over 25 pounds but is generally marketed from 2½ to 10 pounds.

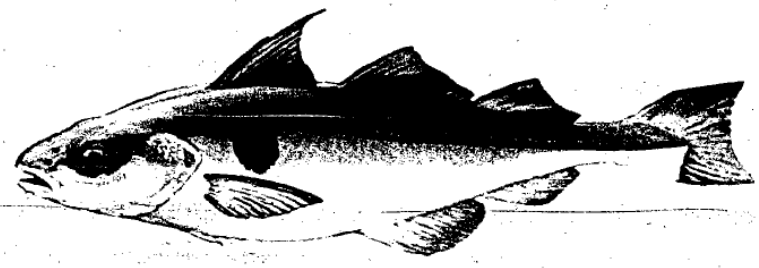
Habitat — Voracious eater; feeds on crab, shrimp, small fish and squid. Lives close to bottom of sea from the intertidal zone to the edge of the continental shelf. Prefers rocky or sandy bottoms and cold water. Caught with line trawls, otter trawls, long lines, floating traps, gill nets. Found on both sides of the north Atlantic. Almost 6 billion pounds of cod are caught each year.

Edibility — Lean fish with large white firm flake. Very light, delicate flavor. Low oil content.

Market Forms — Fresh and frozen: drawn; dressed; fillets, raw and breaded; steaks; frozen specialties; canned; smoked. Sold as jumbo and regular. Scrod is the market term for cod (or haddock) weighing 1½ pounds or less.



HADDOCK



Latin Name — Gadus aeglefinus

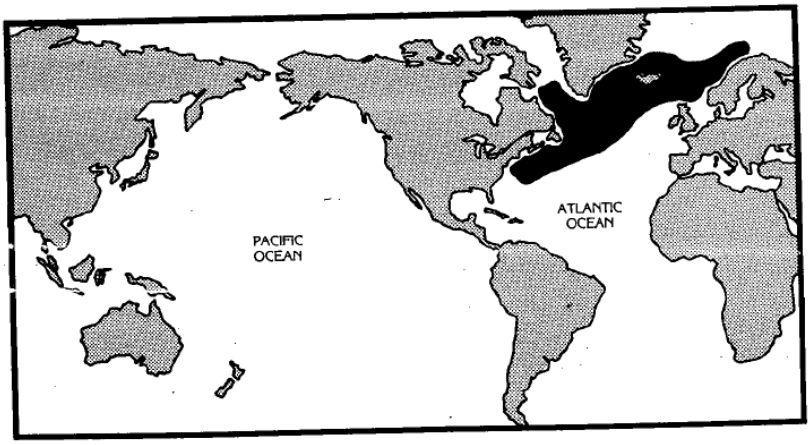
Also Know As — Scrod (1½ lb. or less)

Description — Average weight 2 to 5 pounds. Dark gray on top, pearly gray on bottom, copper on sides with dark lateral line and distinctive dark spot called the "devil's thumbprint" on each shoulder. Has chin barbel, two anal and three dorsal fins. Belongs to the cod family.

Habitat — Lives on or near the sea bottom in the cold north Atlantic waters over the continental shelf. Found at depths of 150 to 450 feet. Carnivorous; feeds on invertebrates and some fishes. Swims in schools. Caught by otter trawls.

Edibility — Lean, white, tender flesh. Mild flavor. Rich in protein, low in fat. Rated highly over white meat fish, usually preferred over cod.

Market Forms — Fresh frozen drawn, dressed, fillets, breaded raw or cooked fillets, stick, portions. Scrod is haddock or cod 1½ pounds or less. Haddock is sold with skin-on and bones removed.



HALIBUT

Latin Name — Hippoglossus hippoglossus - Atlantic
Hippoglossus stenolepsis - Pacific

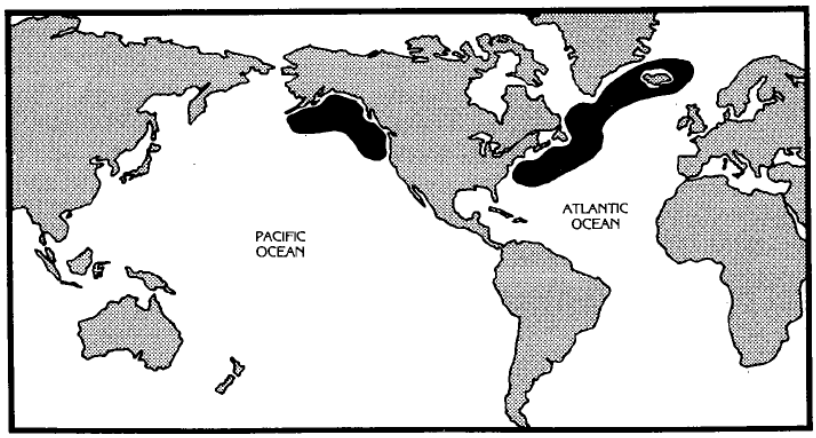
Also Known As — Giant flounder or Pacific halibut

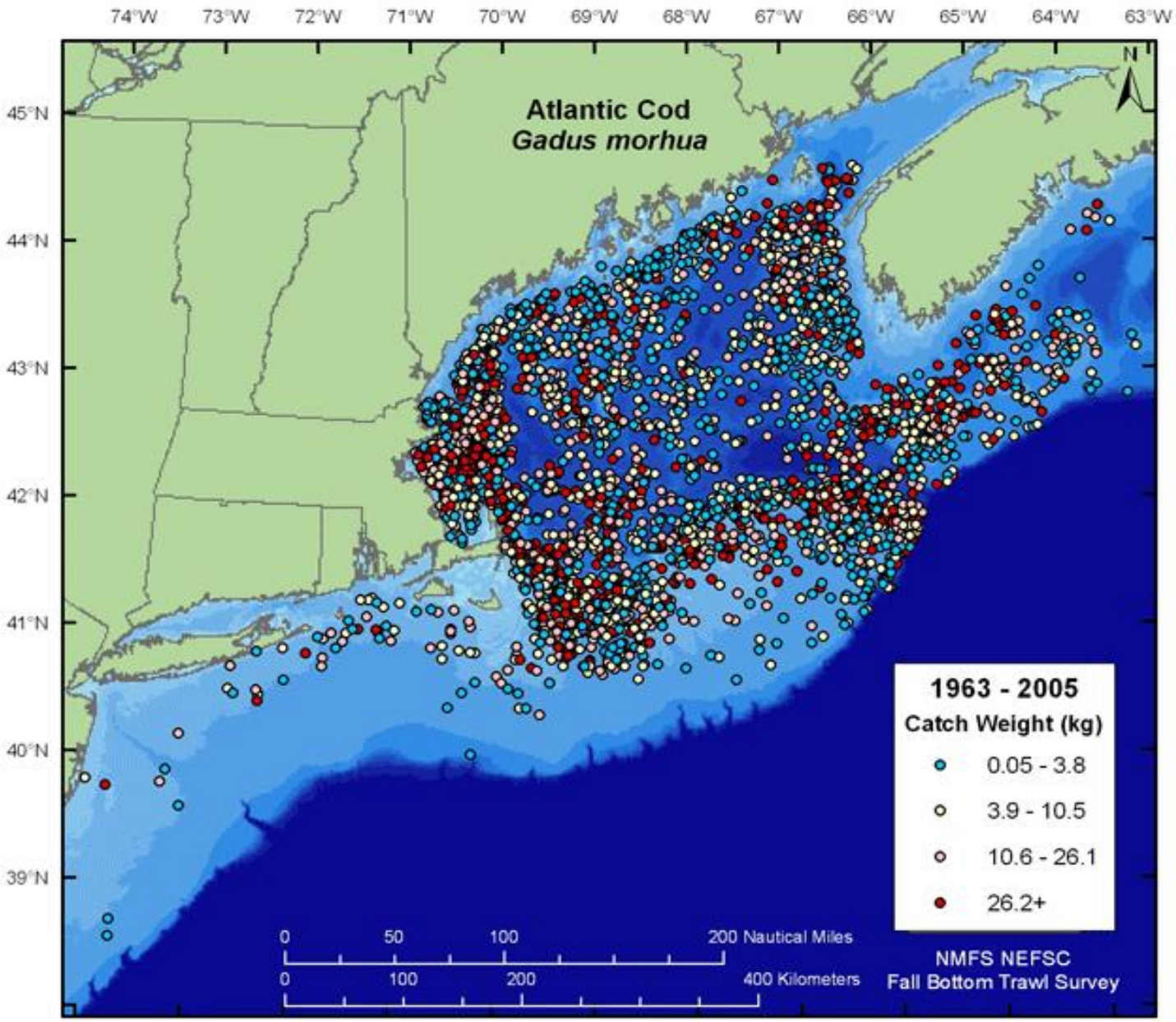
Description — The largest flatfish: average weight 20 to 25 pounds. Brown or greenish-brown on top and whitish on bottom. As a flatfish has eyes and dark color on the top side of body only. Large mouth with sharp, curved teeth. Concave tail. Both species can weigh up to 300 pounds and reach 6 feet in length.

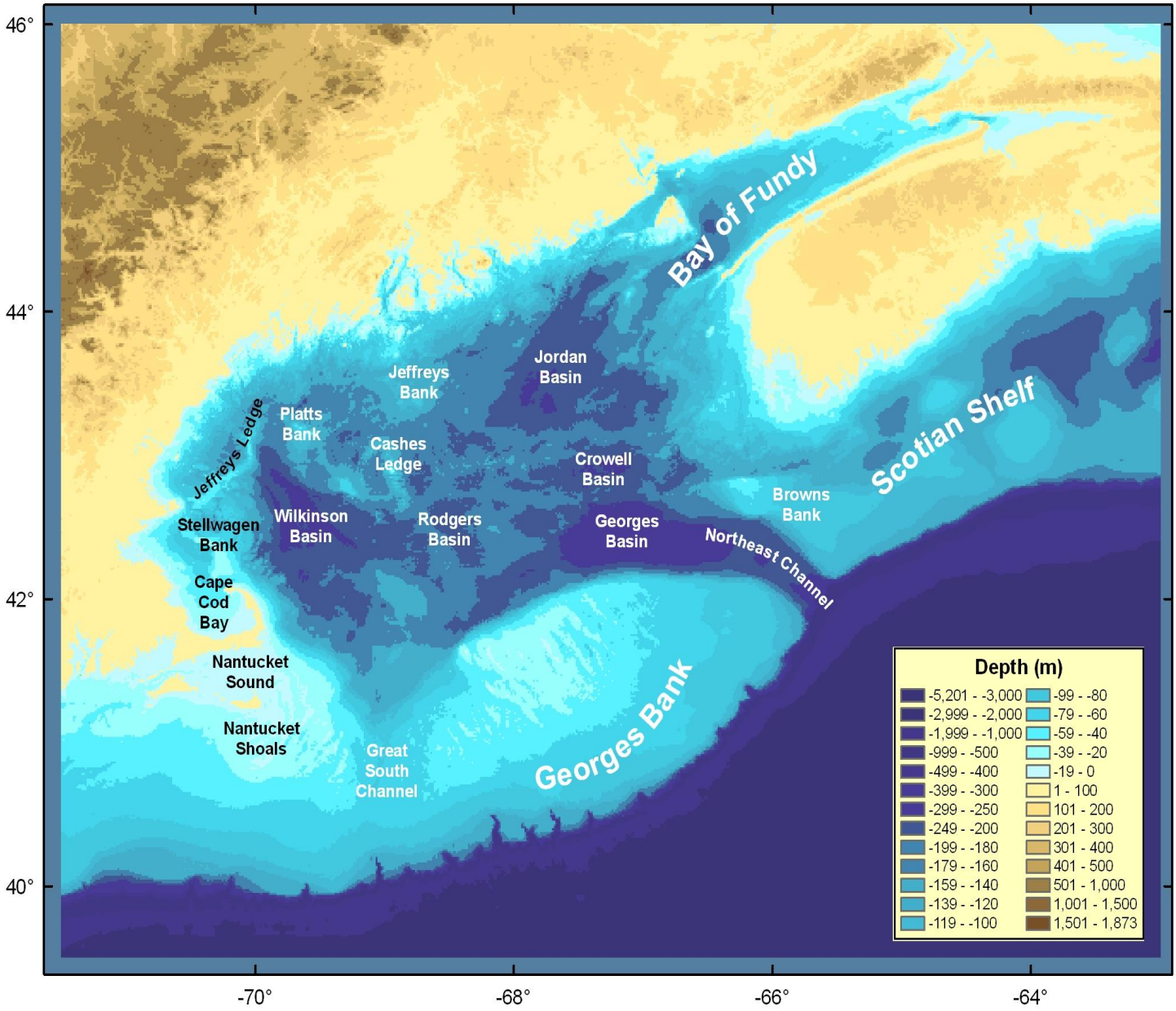
Habitat — Prefers deep seas. Hovers over sand, gravel or clay bottom. Matures at 10 years; may live to be 50. Is caught in the cooler waters of the north Atlantic from New Jersey to Greenland and seldom enters water shallower than 200 feet. Most Pacific halibut are caught off the coast of Alaska and British Columbia. Usually caught by hook and line.

Edibility — Excellent source of protein and minerals. Lean, firm, white meat. Delicate, slightly sweet flavor.

Market Forms — Fresh frozen drawn, dressed, steaks.




Atlantic Cod
Gadus morhua
74°W
73°W
72°W
71°W
70°W
69°W
68°W
67°W
66°W
65°W
64°W
63°W
45°N
44°N
43°N
42°N
41°N
40°N
39°N
N
1963 - 2005
Catch Weight (kg)
0.05 - 3.8
3.9 - 10.5
10.6 - 26.1
26.2+
0
50
100
200 Nautical Miles
0
100
200
400 Kilometers
NMFS NEFSC
Fall Bottom Trawl Survey


46°
44°
42°
40°
-70°
-68°
-66°
-64°
Bay of Fundy
Jordan Basin
Jeffreys Bank
Platts Bank
Jeffreys Ledge
Cashes Ledge
Crowell Basin
Scotian Shelf
Browns Bank
Stellwagen Bank
Wilkinson Basin
Rodgers Basin
Georges Basin
Northeast Channel
Cape Cod Bay
Nantucket Sound
Nantucket Shoals
Great South Channel
Georges Bank
Depth (m)
-5,201 - -3,000
-2,999 - -2,000
-1,999 - -1,000
-999 - -500
-499 - -400
-399 - -300
-299 - -250
-249 - -200
-199 - -180
-179 - -160
-159 - -140
-139 - -120
-119 - -100
-99 - -80
-79 - -60
-59 - -40
-39 - -20
-19 - 0
1 - 100
101 - 200
201 - 300
301 - 400
401 - 500
501 - 1,000
1,001 - 1,500
1,501 - 1,873

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Lead Lining

Inquiry:

If we were fishing, how could we tell what type of habitat and what type of fish are under our boat if we can't see through the water? (depth sounding, charts, experience, lead lining)

Materials:

- Lead lines
- Fish charts

Demo:
What is lead-lining?
What did it tell the fishermen? (characteristics of the bottom, depth)
How did the lead line measure depth? (Knots mark fathoms in line. Lard or other material at the end of the weight collects debris from the bottom or is marked by rocks or shells)

Activity:

1. Divide into groups of 3 or 4 and try the lead lining experiment. Give each group of students a lead line. Explain the parts of the line (line, weight) and how it works.
2. Instruct them to look at the knots in the line explain that each knot represents one fathom. Introduce the word fathom. (means six feet) Have students put tallow or lard on the bottom of the weight.
3. Gently lower the line over the gunwale. Keep easing out the line slowly until the weight is resting on the bottom.
4. Have students mark the nearest knot to their hand.
5. Slowly reel in the line and weight. When the weight is retrieved, have students look at the debris and marking in the lard or tallow.
6. Next have students count the number of knots that are wet. Have students multiply this number by six to calculate the number of fathoms.

Questions to answer:

a. How deep is the water under Adventure?

b. What type of bottom is under the dock?

c. What type of fish from the charts would we most likely find in the water here?

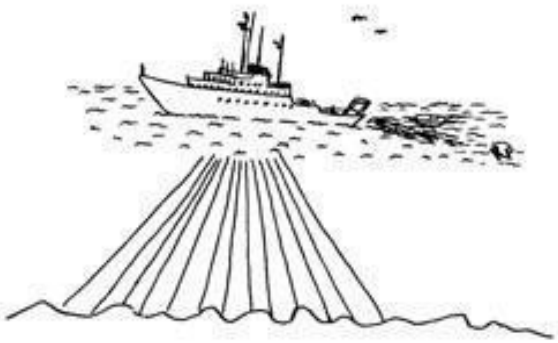
d. How do you know?

Lab: Sonar Mapping of the Ocean Floor

Mapping the ocean floor must be done by *indirect observation*. One current method involves bouncing a sonar signal off the ocean floor and measuring the length of time this signal takes to return. This length can be translated into distance.

$$\text{Distance} = \frac{\text{Speed of Sound X Time}}{2}$$

In this lab, you will be making indirect observations using a wooden rod as the "sonar signal."



Materials per Team:

- Shoe Box (**Do Not Open**)
- Wooden "sounding " rod
- Pencil and paper
- Metric ruler
- Computer with spread sheet program
- Color printer
- Data table

Procedure:

1. Place the wooden rod into one of the holes in the top of the shoebox. Mark the "depth" (length of the rod inside the box).
2. Measure to the nearest millimeter the distance from the lid to where the wooden rod touched the bottom of the box (ocean floor). Do not push down too hard or you will push through the bottom and get a false reading.
   Note: When measuring to the nearest millimeter, there are 10 millimeters in one centimeter. (Example: 2cm and 4mm = 24mm)
3. Subtract your depth measurement from the total depth of the box.
4. Insert each measurement onto the data table.
5. Enter your measurements into a spreadsheet program.
6. Design a color 3-dimensional chart that shows the topography of your "ocean floor."
7. Show your ocean floor bottom to your teacher for permission to print to the color printer.
8. Open your box and compare your ocean floor bottom to the actual "floor."

"EXPLORING OCEAN FEATURES"

QUESTION
What does the land under the sea look like?
How do we show land forms on a map?

UNDERLYING CONCEPT
Underwater topography can vary widely, from smooth slopes to elaborate canyons, valleys, and mountains. This topography is not visible at the ocean surface and is usually too deep to easily explore, therefore scientists have created special measuring methods to map the ocean bottom.

VOCABULARY
bathymetric mapping: the measurement of depths of water in oceans, seas, and lakes
continental shelf: the underwater border of a continent or an island
sea mount: a high hill under the sea
island: land surrounded by water and smaller than a continent
trench: long cut in the ground
volcano: a hill or mountain composed wholly, or in part, of ejected material from within the earth. This material is often, but not always, in the form of lava.

BACKGROUND INFORMATION
Sea floors have a variety of features including smooth gradual slopes, mountain ranges, volcanoes, trenches, and sea mounts. On the east coast of the United States the continental shelf generally extends in a gentle slope under the ocean, however the West Coast, especially off of Southern California, is quite different. Here the near shore land under the sea contains deep submarine canyons, underwater mountain ranges, deep trenches and valleys. The submarine canyons look like canyons cut by rivers on land....which they once were! Although Catalina Island is only 21 miles across the San Pedro Channel from the Southern California coast, deep trenches and canyons in the Channel might reach 490 fathoms (2940 feet)...or over a half-mile deep! The underwater topography of this area is complex and fascinating. Since most students think of a simple sloping sandy bottom under the ocean, it is helpful for them to understand the variety of land forms possible, in terms of geological and geographical knowledge, as well as potential habitat variations.

Measuring and mapping the land under water is called bathymetric mapping. Prior to the 1920's oceanographers measured the depth of the ocean using long lines with weights attached that were marked at regular intervals (meters or feet) with knots. The lines were lowered into the ocean until the weight touched the bottom and the depth was noted by the knot mark. Currently, oceanographers use sonar, or sound waves, to measure the ocean bottom. Sound waves are sent from the bottom of a ship toward the ocean floor. By measuring the time it takes the sound to return to the ship (received by a recording device), the ocean depth can be calculated because the speed at which sound travels through water is known (1,454 meters per second). In the following activity the student will do some simplified versions of bathymetric mapping using "depth lines", as well as some simple topographical mapping.

Source: http://www.usc.edu/org/seagrant/Education/IELessons/Docs/ExploringOceanFeatures.pdf

"SHOE BOX ACTIVITY"

METHODS
Students will create an "ocean bottom" in a shoe box and use measuring skills to decipher what the underlying structures look like when not visible (from the ocean surface).

OBJECTIVES :
Students will be able to:

- create a model of the ocean bottom
- use a grid
- measure the "landforms" in their model

TIME NEEDED
Approximately 2-3 days

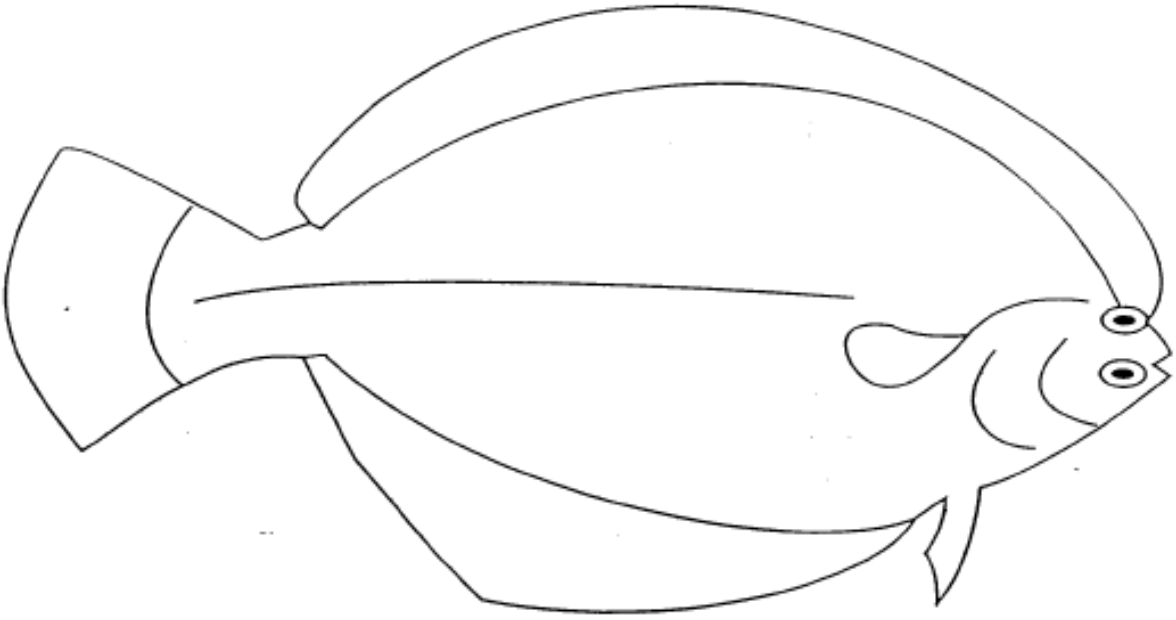
MATERIALS NEEDED

- non-clear shoe boxes (one per group)
- clay or modeling putty
- ruler, tape, probes (pipe cleaners, sharp pencil, etc.)
- cardboard, scissors, pen/pencil, paper

PROCEDURE:
Intro:
Review different types of ocean features or introduce them by direct instruction/discussion.
-What are some notable features you have investigated?
-Where are these features located in the ocean?
-If you were an oceanographer, how would you know where these features were located?
Activity:
1) Using clay or modeling putty, students will work in small groups to construct an ocean bottom inside a shoe box. They need to include at least three different features.
2) When construction is completed, students should cut a card board lid to fit the top of the shoe box.
3) Students draw lines one inch apart on the card board lid in two dimensions to create a grid pattern.
4) Next, tape the lid on top of the shoe box so that other groups cannot see their features.
5) Students will exchange their shoe box for a shoe box from another group to prepare for Part II of this activity.
6) Students will create holes at each 1" intersection along one line of the grid pattern. Insert a pipe cleaner ("depth line") into the holes to determine what "the ocean floor" in the shoe box looks like by calculating how deep they can extend the probe. They will be able to decipher various heights of the "underwater topography." They will draw on paper their idea of the shoe box "ocean floor" based on the information on the probes. (Multiple lines of the grid can be probed to get a three-dimensional picture of the ocean bottom.)
7) Remove the lid of shoe box to see if their drawing matches the contour in the shoe box.
** Note: Students should understand that not every area can be measured and therefore need to create an efficient design for measuring. (This simulates real world scientific research.)*

Source: http://www.usc.edu/org/seagrant/Education/IELessons/Docs/ExploringOceanFeatures.pdf

Hide-a-Fish



This fish is a flat, bottom dwelling fish known as a flounder. Flounders are able to change their skin color to blend in with their environment. This is called **camouflage**. Camouflage helps animals avoid being eaten by making them difficult for predators to see.

Choose a "habitat" in your room, and then color your fish to blend it into that habitat. You could make a rug fish, or a bookshelf fish, or even a table fish! After you have finished coloring, cut your fish out and tape it to its habitat. How well is it hidden?

New England Aquarium

II. Investigating Life Cycle of Cod, Haddock and Halibut

Materials:

- NOAA – Essential Fish Habitat Descriptions for Cod, Haddock and Halibut
- Chart paper
- Markers
- " North Atlantic Fish Populations Shifting as Ocean Temperatures Warm" article

Inquiry Questions and Objectives:

1. What are the stages of the life cycles?
2. What do they need to survive?
3. Can changes to habitat influence life cycle?

Activities:

A. Inquiry discussion (KWL) – Looking at body structure -
    1. What can you tell me about their livelihood?
    2. How does habitat affect life cycle?
B. Identify Life Cycles of Cod, Haddock and Halibut
    1. Essential Fish Habitat Descriptions for Cod, Haddock and Halibut WS
        1. compare and contrast life cycle stages (3 groups – each does one fish)
    2. Make life cycle charts
C. Identify Survival Needs of Cod, Haddock and Halibut
    1. Essential Fish Habitat Descriptions for Cod, Haddock and Halibut WS
        a. compare and contrast habitat needs for life cycle stages
    2. Add needs to charts
D. What Changes Are Affecting these fish's life cycles?
    1. Discuss and chart effects in " North Atlantic fish Populations Shifting as Ocean Temperatures Warm"

Essential Fish Habitat Description
Atlantic cod (*Gadus morhua*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined the Gulf of Maine stock of cod is considered overfished, based on the fishing mortality rate. The Georges Bank stock of cod is not considered overfished, also based on the fishing mortality rate associated with this stock. For both stocks of cod, essential fish habitat is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 1.1 - 1.4 and in the accompanying table and meet the following conditions:

Eggs: Surface waters around the perimeter of the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England as depicted in Figure 1.1. Generally, the following conditions exist where cod eggs are found: sea surface temperatures below 12°C, water depths less than 110 meters, and a salinity range from 32 - 33‰. Cod eggs are most often observed beginning in the fall, with peaks in the winter and spring.

Larvae: Pelagic waters of the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England as depicted in Figure 1.2. Generally, the following conditions exist where cod larvae are found: sea surface temperatures below 10°C, waters depths from 30 - 70 meters, and a salinity range from 32 - 33‰. Cod larvae are most often observed in the spring.

Juveniles: Bottom habitats with a substrate of cobble or gravel in the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England as depicted in Figure 1.3. Generally, the following conditions exist where cod juveniles are found: water temperatures below 20°C, depths from 25 - 75 meters, and a salinity range from 30 - 35‰.

Adults: Bottom habitats with a substrate of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay as depicted in Figure 1.4. Generally, the following conditions exist where cod adults are found: water temperatures below 10°C, depths from 10 - 150 meters, and a wide range of oceanic salinities.

Spawning Adults: Bottom habitats with a substrate of smooth sand, rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay as depicted in Figure 1.4. Generally, the following conditions exist where spawning cod adults are found: water temperatures below 10°C, depths from 10 - 150 meters, and a wide range of oceanic salinities. Cod are most often observed spawning during fall, winter, and early spring.

The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.

Source: http://www.nero.noaa.gov/hcd/cod.pdf

Essential Fish Habitat Description
Haddock (*Melanogrammus aeglefinus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined the Georges Bank stock of haddock is neither currently overfished nor approaching an overfished condition. The report also concluded that there is not enough information to determine if the Gulf of Maine stock is overfished or approaching an overfished condition. For both stocks of haddock, essential fish habitat is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 2.1 - 2.4 and in the accompanying table and meet the following conditions:

Eggs: Surface waters over Georges Bank southwest to Nantucket Shoals and the coastal areas of the Gulf of Maine as depicted in Figure 2.1. Generally, the following conditions exist where haddock eggs are found: sea surface temperatures below 10°C, water depths from 50 - 90 meters, and salinity ranges from 34 - 36‰. Haddock eggs are most often observed during the months from March to May, April being most important.

Larvae: Surface waters over Georges Bank southwest to the middle Atlantic south to Delaware Bay as depicted in Figure 2.2. Generally, the following conditions exist where haddock larvae are found: sea surface temperatures below 14°C, water depths from 30 - 90 meters, and salinity ranges from 34 - 36‰. Haddock larvae are most often observed in these areas from January through July with peaks in April and May.

Juveniles: Bottom habitats with a substrate of pebble gravel on the perimeter of Georges Bank, the Gulf of Maine, and the middle Atlantic south to Delaware Bay as depicted in Figure 2.3. Generally, the following conditions exist where haddock juveniles are found: water temperatures below 11°C, depths from 35 - 100 meters, and a salinity range from 31.5 - 34‰.

Adults: Bottom habitats with a substrate of broken ground, pebbles, smooth hard sand and smooth areas between rocky patches on Georges Bank and the eastern side of Nantucket Shoals, and throughout the Gulf of Maine, plus additional area of Nantucket Shoals and the Great South Channel inclusive of the historic range as depicted in Figure 2.4. This additional area more accurately reflects historic patterns of distribution and abundance. Generally, the following conditions exist where haddock adults are found: water temperatures below 7°C, depths from 40 - 150 meters, and a salinity range from 31.5 - 35‰.

Spawning Adults: Bottom habitats with a substrate of pebble gravel or gravelly sand on Georges Bank, Nantucket Shoals, along the Great South Channel, and throughout the Gulf of Maine, plus additional area inclusive of the historic range as depicted in Figure 2.4. Generally, the following conditions exist where spawning haddock adults are found: water temperatures below 6°C, depths from 40 - 150 meters, and a salinity range from 31.5 - 34‰. Haddock are observed spawning most often during the months January to June.

Source: http://www.nero.noaa.gov/hcd/haddock.pdf

Essential Fish Habitat Description
Atlantic halibut (*Hippoglossus hippoglossus*)

According to the NMFS' *Report to Congress: Status of the Fisheries of the United States* (September 1997), Atlantic halibut is currently overfished. This determination is based on an assessment of stock level. Essential Fish Habitat for Atlantic halibut is described as the area of the coastal and offshore waters (out to the offshore U.S. boundary of the Exclusive Economic Zone) that is designated on Figure 18.1 and meets the following conditions:

Eggs: Pelagic waters to the sea floor of the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut eggs are found: water temperatures between 4 and 7°C, water depths less than 700 meters, and salinities less than 35‰. Atlantic halibut eggs are observed between late fall and early spring, with peaks in November and December.

Larvae: Surface waters of the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut larvae are found: salinities between 30 and 35‰.

Juveniles: Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut juveniles are found: water temperatures above 2°C and depths from 20 - 60 meters.

Adults: Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut adults are found: water temperatures below 13.6°C, depths from 100 - 700 meters, and salinities between 30.4 - 35.3‰.

Spawning Adults: Bottom habitats with a substrate of soft mud, clay, sand, or gravel in the Gulf of Maine and Georges Bank, as well as rough or rocky bottom locations along the slopes of the outer banks, as depicted in Figure 18.1. Generally, the following conditions exist where spawning Atlantic halibut are found: water temperatures below 7°C, depths less than 700 meters, and salinities less than 35‰. Atlantic halibut are most often observed spawning between late fall and early spring, with peaks in November and December.

The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.

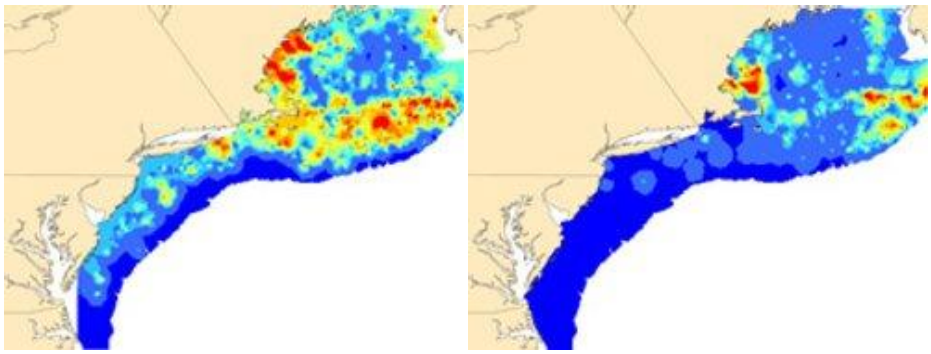
Source: http://www.nero.noaa.gov/hcd/halibut.pdf

Type	Cod	Haddock	Halibut
Eggs	• sea surface • temperatures below 12°C • water depths less than 110 meters • salinity range from 32 - 33‰. • beginning in the fall, with peaks in the winter and spring	• sea surface • temperatures below 10°C • water depths from 50 – 90 meters • salinity ranges from 34 - 36‰. • during the months from March to May	• Pelagic waters to the sea floor • water temperatures between 4 and 7° C • water depths less than 700 meters • salinities less than 35‰. • between late fall and early spring, with peaks in November and December
Larvae:	• Pelagic waters temperatures below 10°C, waters • depths from 30 - 70 meters • salinity range from 32 - 33‰ • in the spring.	• sea surface temperatures below 14°C • water depths from 30 - 90 • salinity ranges from 34 - 36‰. • from January through July with peaks in April and May	• Surface waters • salinities between 30 and 35‰
Juveniles:	• Bottom habitats with a substrate of cobble or gravel • water • temperatures below 20°C • depths from 25 - 75 meters • salinity range from 30 - 35‰	• Bottom habitats with a substrate of pebble gravel • Water temperatures below 11°C • depths from 35 - 100 meters • salinity range from 31.5 - 34‰	• Bottom habitats with a substrate of sand, gravel, or clay • water temperatures above 2°C • depths from 20 – 60 meters

Type	Cod	Haddock	Halibut
Adults:	• Bottom habitats with a substrate of rocks, pebbles, or gravel • water temperatures below 10°C • depths from 10 - 150 meters • wide range of oceanic salinities	• Bottom habitats with a substrate of broken ground, pebbles, smooth hard sand and smooth areas • water temperatures below 7°C • depths from 40 - 150 meters • salinity range from 31.5 - 35‰.	• Bottom habitats with a substrate of sand, gravel, or clay • water temperatures below 13.6°C, • depths from 100 – 700 meters • salinities between 30.4 - 35.3‰
Spawning Adults:	• Bottom habitats with a substrate of smooth sand, rocks, pebbles, or gravel • water temperatures below 10°C • depths from 10 - 150 meters • wide range of oceanic salinities. • during fall, winter, and early spring	• Bottom habitats with a substrate of pebble gravel or gravelly sand • water temperatures below 6°C • depths from 40 - 150 meters • salinity range from 31.5 - 34‰ • during the months January to June	• Bottom habitats with a substrate of soft mud, clay, sand, or gravel • water temperatures below 7°C • depths less than 700 meters • salinities less than 35‰. • Between late fall and early spring, with peaks in November and Dec

North Atlantic Fish Populations Shifting as Ocean Temperatures Warm

January 5, 2010 · Posted in Commercial Fishing, Industry News



Cod population 1968-1972 (left) and 2003-2008 (right) (Credit: Janet Nye, NEFSC/NOAA)

About half of 36 fish stocks in the Northwest Atlantic Ocean, many of them commercially valuable species, have been shifting northward over the last four decades, with some stocks nearly disappearing from U.S. waters as they move farther offshore, according to a study by NOAA researchers.

The findings, published in the November edition of Marine Ecology Progress Series, show the impact of changing coastal and ocean temperatures on fisheries from Cape Hatteras, N.C. to the Canadian border.

Janet Nye, a postdoctoral researcher at NOAA's Northeast Fisheries Science Center (NEFSC) laboratory in Woods Hole, Mass. and the lead author of the study, analyzed research vessel survey data collected every spring from 1968 through 2007. The study focused on familiar fish species, including Atlantic cod, haddock, yellowtail and winter flounders, spiny dogfish and Atlantic herring, as well as several less well-known species like blackbelly rosefish.

Historic ocean temperature records and long-term processes like the Atlantic Multidecadal Oscillation and the North Atlantic Oscillation dating back to 1850 were also analyzed to put recent temperature increases into context.

"During the last forty years, many familiar stocks have been shifting to the north where ocean waters are cooler, or staying in the same general area but moving into deeper, cooler\ waters than where they traditionally have been found," Nye said. "They all seem to be adapting to changing temperatures and finding places where their chances of survival as a population are greater."

Nye and coauthors Jason Link, Jonathan Hare and William Overholtz of NEFSC selected the 36 species to study because these were consistently caught in high numbers in the Center's annual spring bottom trawl surveys. NEFSC conducts annual spring and fall trawl surveys and has the world's longest time series of standardized fishery population data.

The researchers looked at where the fish were caught and their total population weight in each year of the survey. For each stock, they estimated the center of abundance, or where the bulk of the fish were found,

as well as average depth, the range or area that the stock occupied, and the average temperature at which the stock was found.

They also took into account fishing activities on the species over time, as well as natural cycles in ocean temperature. Ocean temperatures in the northwest Atlantic have increased since the 1960s and 1970s, and the authors found significant changes in species distribution consistent with warming in 24 of the 36 stocks studied.

Ten of the 36 stocks examined had significantly expanded their range, while 12 had significantly reduced it. Changes in a species range can be caused by both temperature changes and fishing activity, with heavily fished stocks appearing more sensitive to climate change and often showing a larger shift. Seventeen of the 36 stocks occupied increasingly greater depths, and three stocks occupied increasingly shallower waters. However, the temperature at which each stock was found did not change over time, suggesting that fish are moving to remain within their preferred temperature range.

While consumers will find familiar fish species at their local fish markets for the foreseeable future, fisherman may have to travel farther to catch some species until eventually it will not be economical. The authors say the study has implications beyond the Northeast U.S. “It is another example of the need for an ecosystem-based management approach to our fisheries,” said coauthor Jason Link, a fisheries biologist at NEFSC. “Many factors, temperature among them, affect the status of a fish stock, and all of these influences need to be considered in management decisions. Looking at ‘the big picture’ helps put each piece of the puzzle in perspective.”

Source: http://blog.marport.com/category/industry-news/commercial-fishing/

III. Food Chains and Food Webs

Materials

- Food Chains in the Sea WS
- Food Chain and Food Web sheets
- Ocean Food Chain Mobile sheets
- Computers – online
- Webbing the Sea WS
    - Yarn
    - Name cards

Inquiries Questions and Objectives:

1. Looking at body structure, what do you think they ate?
2. Food chain vs. web – What the difference?
3. How has human activity affected food webs?

Activities:

A. Inquiry discussion (KWL) – Looking at body structure -
    1. What do you think they ate?
    2. What might eat them?
B. Food Chains in the Sea WS
    1. Read through Food Chain and Food Web sheets
    2. Map out a sample ocean food chain
C. Ocean Food Chain Mobile
    1. Research and fill out food chain mobile
D. Webbing the Sea WS
    1. Review and discuss adaptations

Food Chains in the Sea

Objective;

- Be able to explain the importance of keeping the food chains in the sea unbroken.
- Use plants and animals in the environment and in the sea.

In this lesson children should understand that all plants and animals in the sea are important because they are related by food chains. Plants and animals depend on each other for food and when they die their bodies are rotted by bacteria to be used by simple plants and animals again. You can think of the food chains usually or by particular examples.

An example of a food chain is seaweed is eaten by a shellfish is eaten by a fish is eaten by a bird. Seaweed Shellfish Fish Bird When each of these animals dies, the material in their bodies decomposes and can be used by the seaweed again. However, if you eat all the shellfish or fish then the food chain is broken.

Usually plants are eaten by animals are eaten by larger animals are eaten by larger animals. If ">>" means "is eaten by", you can show a food chain as: plants >> small fish >> big fish >> shark >> man
If you kill all the animals or plants in any step of the food chain then the food chain is broken and all the living things in the food chain are affected.

1. Give examples of living things in the sea eating other living things, e.g. smaller fish eaten by sharks. Write all the examples on the chalk board. So far you have steps in the food chain, tell the children to tell you a third or fourth step, e.g. seaweed, fish, shark, man.
2. Can you make different food chains? Can you make food chains with many steps? Try this with the children and write the steps on the chalk board.
3. What is passed along the food chain? [The material in the bodies of the plant and animals.] What happens to the materials when the plants or animals die and are not eaten? [They rot.] Is the material of their bodies lost from the food chain? [No, simple plants and animals can use it again.]
4. Show the general food chain. Plants fish one fish two shark
5. The dotted lines show the bodies of dead plants and animals made rotten by bacteria then used by plants again. What would happen if you caught all the fish? [There would be no food for fish two and later no food for the sharks. The food chain would be broken.]
6 . Name any kinds of animals or plants in the sea that could be wiped out by too much fishing or hunting. How many animals of the sea should you catch? [Catch some but do not catch so many to break the food chain.]

Extra Activity
Discussion with an old fisherman or fisheries officer on whether there are as many fish now as before. Are some food chains already broken? Visits to agricultural departments (fishery section) can help us to find out more about this.

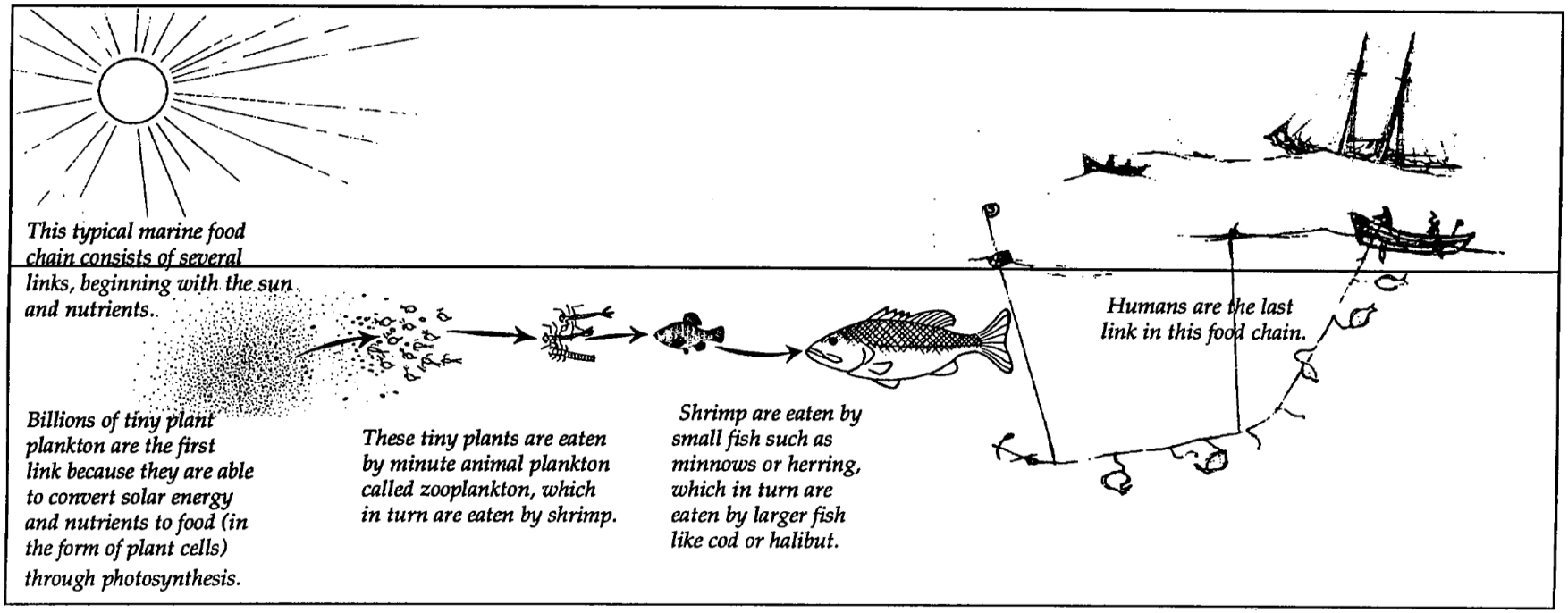
Source: http://www.uq.edu.au/_School_Science_Lessons/year5.html#5.6

Food Chains

Besides sunlight and nutrients, all ocean plants and animals need a place to live and grow. A plant or animal's living place is called a **habitat**. A habitat is the particular part of the environment which fulfills the needs of the plant or animal, providing its food, shelter and protection. It is like a neighborhood or community. The sea has many different types of habitats such as salt marshes, banks, ledges, bays, and the deep sea.

Each type of plant or animal in a habitat plays a special role in the survival of the community. An organism's role in the habitat is called its **niche**. A niche is like a job that the plant or animals performs within its habitat. For example: the role or niche of the codfish is to eat small fish like herring. In this case the codfish is called a **predator** and the herring is its **prey**. In turn, humans eat codfish. Now humans can be called predators and the codfish the prey. Ocean plants have niches also. Kelp is a producer of food which in turn is eaten by a consumer like a sea urchin.

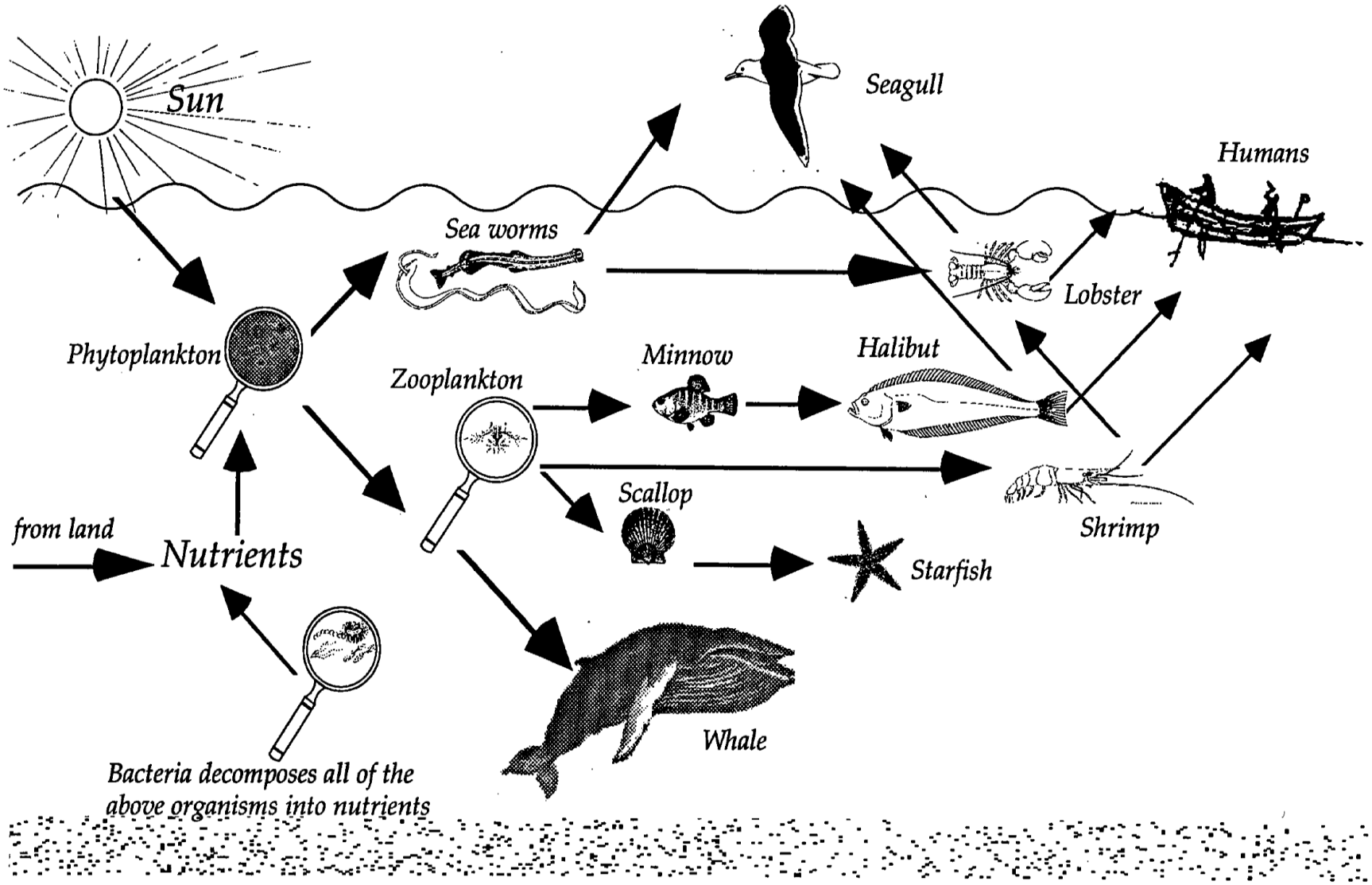
A **food chain** shows how plants and animals are related as producers and consumers in their niches. Each living thing depends upon other living things. In the ocean there are many different kinds of food chains. The picture below shows an example of a marine food chain.



Food Webs

All food chains also have one or more links in common with other food chains. The inter-linking of food chains is called a **Food Web**. In the food web below, you can see how living and the non-living are **interconnected** in the ocean ecosystem.

Humans can endanger a food web by overfishing or pollution of a habitat. If an area becomes polluted with a **toxic** chemical such as oil, all the phytoplankton or small fish might die. This would break the food web and can cause many other living things to die. *See Activity – Webbing the Sea on page 77 and Activity – Toxic Chains on page 79.*



Ocean Food Chain Mobile

Using the information gathered from your Internet searches and recorded on your Food Chain chart, build a mobile featuring each piece of the food chain.

The top of the mobile should be the animal at the top of the food chain.

The order going down should match the food chain of who eats whom.

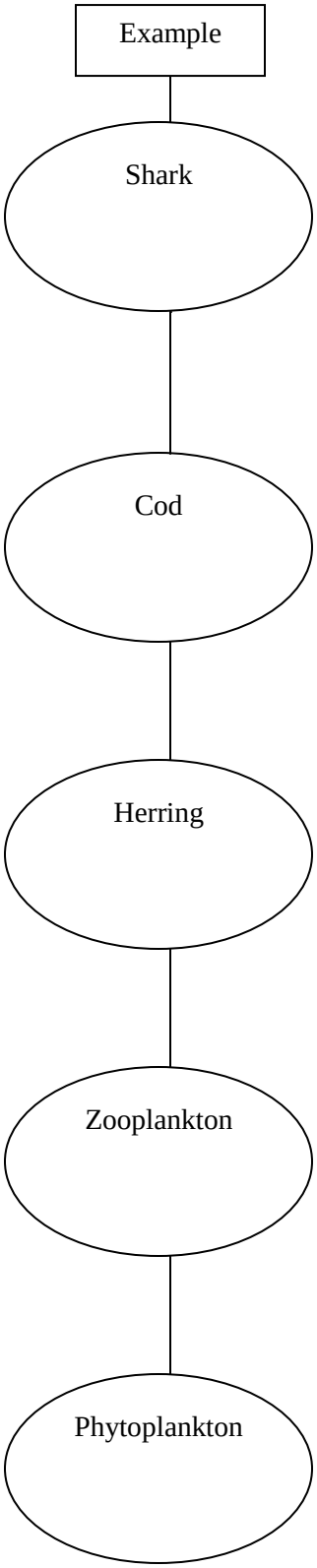
The bottom of the mobile should be (plant) phytoplankton.

Each piece of the mobile should have a picture of the animal on one side and the name with 4 facts about that animal on the other side.

Due Date:

_____

(Please bring the Ocean Food Chain Chart in with the mobile.)



Name _____

Ocean Food Chain Chart

_____

1. _____
2. _____
3. _____
4. _____

↓

_____

1. _____
2. _____
3. _____
4. _____

↓

_____

1 _____
2. _____
3. _____
4. _____

↓

Webbing the Sea

Materials:

- ball of yarn
- name tags

Procedure:

A. Brainstorm with your class a recipe for making an ocean. What are all the different things (living and non-living) that you can find in the ocean? Listed below are some suggestions to start and sustain the brainstorming:

salt water	marsh plants
wind	sun light
sea birds	plankton
crustaceans – crabs, lobsters	whales
people/fishermen	sea plants
algae	fish

B. Put the recipe on the blackboard and have each student pick an item from the recipe that he or she would like to be.

C. Write the student's name next to the item on the board and have him or her make a large nametag of the item ach student chose. A picture or simple drawing added to the tag can be helpful.

D. Arrange the participating students in a circle.

E. Give one child the ball of yarn and have him or her hold the end and pass the ball to someone their ocean organism influences or is influenced by. Example: Cod might pass the ball to herring. Herring would hold the yarn and pass to plankton. Plankton would pass the ball to Light. Light could pass to algae, etc. Use the food web example in the text if needed.

F. Continue until everyone is connected to at least one other person.

G. Next, make a statement such as " A ship had just spilled toxic oil into the ocean and all the plankton are dying."

H. Have the plankton move away from the circle. In turn have each student whose line is being pulled follow the person that is moving.

I. Discuss the results of this action. Explore what happens when one thing is removed from the food web. Have the students identify the other plants and animals affected.

Questions for Discussion

1. Have the students list what they had for breakfast. Have them draw a diagram of the food chain or web represented by some of these foods. Discuss the results.

2. Discuss how other forms of pollution such as sewage, toxic chemicals, radiation, acid rain, global warming effect the food web.

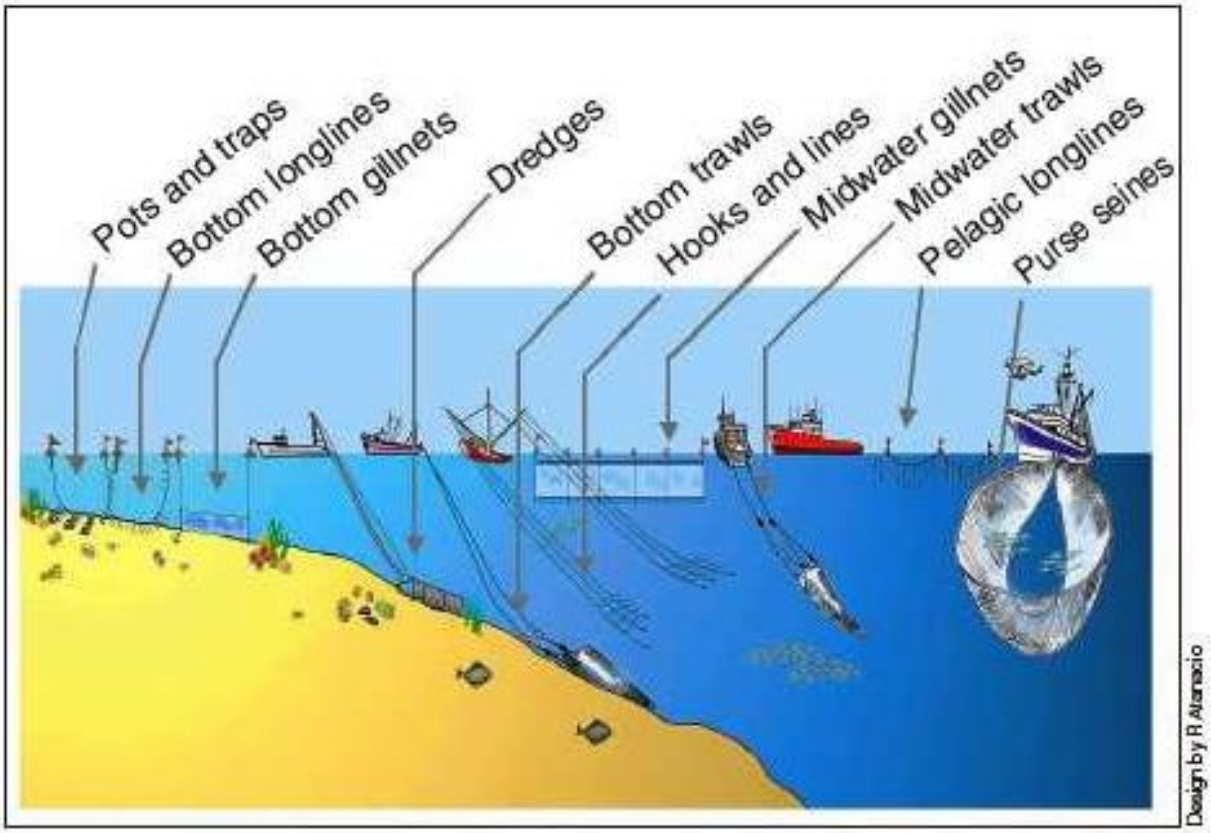
3. Discuss how overfishing or the destruction of salt marshes affects a food web.

Part 2 – Who Else Is Here? The Fishing Industry

I. Methods used to catch fish
   A. How can you catch a fish?
   B. How can you catch lots of fish?

II. Sustainability? Is it Possible?
   A. What happens if you catch too much?
   B. How can you catch certain kinds of fish?
   C. What are we doing to the fish habitats?

II. Changes in fishing technology
   A. What do you need to know to design own fishing gear to catch a target fish?
   B. What would you need to build and test?
   C. What works? What doesn't? Why?



I. Methods Used To Catch Fish

Materials:

A. Fishing Vessels and Equipment info sheets
B. Computers – online
C. T - Chart paper - Pros and Cons

Inquiry Questions and Objectives

1. How can you catch a fish?
2. How can you catch lots of fish?
3. What are the pros and cons of the different types of fishing methods?

Activities:

A. Research fishing methods - Fishing Vessels and Equipment info sheets
   1. Visit online - Monterrey Bay – Seafood Watch – Fishing Methods and Wild Seafood http://www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_gear.aspx
   2. Visit online - Fishing Vessel/ Gear Fact Sheet http://www.fao.org/fishery/geartype/search/en
B. Chart pros and cons of different types of fishing methods

Fishing Vessels and Equipment

Until the mid-20th century, fishing boats were largely of local design, with different types found even in adjacent ports. As fishermen started to roam farther afield for their catches, the vessels grew, and with this growth in size came an element of standardization in design. Today, fishing boat design and construction is an international industry, with the different vessel types dictated more by the fishing methods for which they are designed rather than by their port of origin.

The establishment of the 200 mile fishing limits (in 1976 – known as the Magson Act) has altered fishing patterns and, with them, the types of vessels used by many countries. In the United States and Canada, fishing vessels have grown with the introduction of processing or factory trawlers, while the huge fleets of this type of vessel operated by Soviet-bloc countries and Japan have shrunk. In western Europe, compact fishing vessels have been developed with high catching power. The advantage of these smaller vessels is their reduced capital and operating costs.

Steel is the most common construction material, being used extensively on larger vessels (above 25 meters). Traditional wood construction is less common because of cost and a lack of suitable timber in many areas. The use of fiberglass is increasing in smaller fishing vessels, and it is now used in vessels of up to 25 meters in length.

The aim in all fishing boat development is to improve efficiency by building vessels that have higher catching power, smaller crews, and reduced operating costs. This development must be matched against safety concerns, as commercial fishing is one of the highest risk industries in the world. Several countries have introduced regulations governing the construction and operation of fishing vessels. The International maritime Organization, convened in 1959 under the auspices of the United nations, is responsible for devising international regulations covering such aspects of fishing vessel design as construction, stability, safety equipment, and watertight integrity. These regulations are likely to lead to further standardizations in design

The Food and Agriculture Organization of the United Nations has introduced a classification scheme of fishing vessels based primarily on the gear used.
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Trawlers

Most trawlers are single-screw vessels with powerful engines and deck machinery for dragging the trawl nets.

Side trawlers

On this traditional type of trawler, the trawl is launched and recovered from the side of the vessel. The side trawler is characterized by the wheelhouse and superstructure at the stern and a raised forecastle at the bow. The hull lines follow a traditional seaworthy form, with a pronounced deck sheer giving a high bow and stern. The working deck may be covered.

Stern trawler

Practically all trawlers built today are stern trawlers, with the trawl launched and recovered over the stern. The vessels are generally designed with the wheelhouse and superstructures forward, often forming part of the raised forecastle. By contrast, the working deck aft is lower, and, on the the larger trawlers, a ramp is built into the stern up which the trawl is pulled onto the deck. On smaller stern trawlers, the trawl is lifted on board by a hoist.

Factory or processing trawlers
These are the large type of fishing vessel. After catching and sorting, the fish are transferred to the processing deck, where they are processed and packaged. It is then frozen and stored in the hold. Many vessels have facilities for extracting oil and for making fishmeal from waste products. Factory trawlers accommodate large crews and stay at sea for many weeks. They often support a fleet of smaller trawlers; when they load fish from other vessels rather than catching it themselves, they are called Klondike's.

Seine
Seiners range in size from canoes, where the net is hauled by hand, to larger vessels with powerful net-handling equipment. This equipment generally consists of a power block mounted on a crane placed aft of the wheelhouse, as well as winches and drums for hauling and storing the great lengths of net and rope required for seine fishing.

Purse Seiners
In purse seining, the fish shoal is surrounded by the net, which has a rope that seals the bottom of the net to trap the fish. Small fish may be pumped out of the net, or the net can be hauled on board and the fish released for sorting.

The North American purse seiner is generally laid out with a forward wheelhouse and aft working deck. A characteristic of this vessel is the powerful net block on the end of a long boom supported by the mast and a crow's nest on the mast for spotting fish shoals.

Tuna purse seiners are large vessels mainly designed for long-range fishing, although smaller types operate in the Mediterranean. They are similar in design to, but larger than, the North American purse seiner, and they have a sloping stern where a tuna skiff, used for laying the net, is stowed. Several smaller boats are also carried to help with handling the catch and removing unwanted or protected fish from the nets. In addition to the crow's nest for spotting fish shoals, a light helicopter is sometimes carried on a helicopter deck above the forward wheelhouse. Modern tuna vessels store the catch in chilled seawater tanks.

Gill-netters
Gill nets are used by all sizes of fishing boat up to 20 meters in length. There is no characteristic style, although this type of vessel often uses a steadying sail to keep heading into the wind. The nets may be set and hauled by hand or by power blocks at deck level.

Potters
These are generally inshore vessels using pots or traps to catch shellfish. They come in a variety of types and sizes, but a typical inshore potter is 10 meters in length. King crab potters working off the coast of Alaska are up to 30 meters in length; they generally have the wheelhouse forward to leave a clear working deck aft, but smaller vessels can have the wheelhouse at either end. A characteristic of the potters is the pot stowage, which is usually a large frame construction aft. Gear is handled with a crane on larger vessels and with a bulwark-mounted pot hauler on smaller vessels.

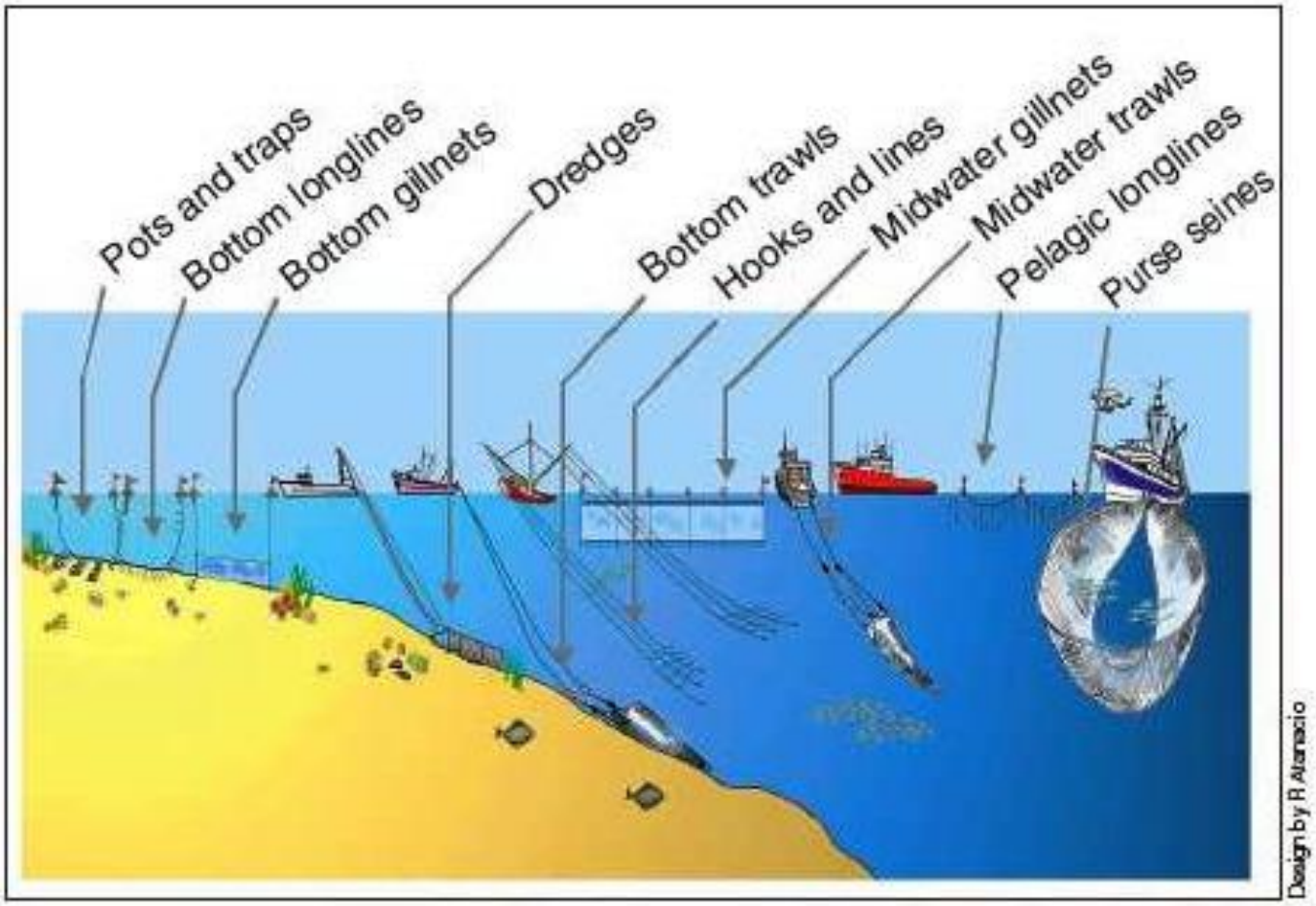
Liners
Fishing with line and hooks is carried out by a wide range of vessels using either manual or mechanical hauling.

Handliners
These are generally small fishing boats, open or decked, working inshore waters.

Longliners
These tend to be larger vessels with the hooks and line attached to a rope that is supported by floats or simply trailed. Usually there is an automatic line system whereby the hooks are baited and fish removed mechanically in what can be a continuous system. As line-caught fish tend to be of the best quality, chilled seawater tanks are often installed to maintain freshness. The largest types of longliners are those fishing for tuna, these can be more than 60 meters in length.

Multipurpose fishing boats
Because fishing for certain species of fish is often seasonal, many modern fishing boats are designed to incorporate two or more different fishing methods. Typical is the trawler/purse seiner, potting vessels and longliners can also be equipped for trawling. Trawlers can also work at pair trawling, in which a trawl is pulled between two vessels. This may require heavier gear to handle the larger trawl.

Mother Ship
This category generally covers vessels carrying small fishing boats that return to the mother ship with their catch. They are generally ocean going vessels with extensive on-board facilities for processing and freezing the catch. The category can also include factory trawlers supporting a fleet of smaller catching vessels that are not carried on-board.



II. Sustainability? Is it Possible?

Materials:

- What Problems are Facing the Fishing Industry handout
- Overfishing Activities 1 &2 WS
    - Pans or trays to hold "fish" (11" x 15" baking pans work well)
    - About 15 goldfish crackers per pan
    - About 10 colored goldfish crackers per pan blue ("bluefin tuna") are especially valuable
    - Straws to use for catching fish
    - Cups for collecting caught fish
- Habitat Destruction WS
    - fish
    - aquarium
    - plastic aquarium plants (50)
    - different colored jacks (20)
    - small fish nets
    - sanded/rocky bottom
- By-catch Activity WS
    - various small-sized plastic fish
    - marine animals
    - large bucket
    - Dixie cups

Inquiry Questions and Objectives:

1. What happens if you catch too much?
2. How can you catch certain kinds of fish?
3. What are we doing to the fish habitats?

Activities:

A. Overfishing Activities 1 &2

B. Habitat Destruction Activity

C. By-catch Activity

What Problems are Facing the Fishing Industry

Summary
Our project focuses on the impact of commercial fishing on the marine environment. Because humans rely on the sea as an important source of food and resources, they tend to overexploit its precious commodities. Many species of animals and plants are endangered due to the destructive nature of methods used for harvesting. Three major issues threatening marine species include over-fishing (catching more fish than can be reproduced), habitat destruction (destroying of the marine environment through human use), and by-catch (unwanted species of marine life that is caught). We intend to show how fishing practices create these problems and the effects that they have on fish populations. Through three different projects, we hope to help children better understand the negative effects of commercial fishing, raise their awareness of the need to conserve marine environments, and develop safer and better ways to obtain ocean resources.

Background information
Human impact on the marine environment extends to many areas and is frequently very detrimental. In particular, the fishing industry affects both target (wanted) and by-catch (non-wanted) species as well as threatening the stability of many habitats. By-catch includes any marine organisms which are inadvertently captured and/or killed through fishermen's activities. It can range from something as small as a snail to dolphins and porpoises. The proportion of by-catch species to target species is frequently as great as 100:1. The target species itself also suffers due to constant overfishing, which disallows the population to sustain its numbers through reproduction. Because populations are fished above their maximum sustainable yields (highest number fishermen can catch of one species without causing population desecration), they can be driven to extinction over time. Finally, habitat destruction occurs during fishing processes such as trawling (form of fishing where a net is dragged on the ocean bottom). Thus human impact extends far beyond the species that are targeted for consumption and threatens the entire marine ecosystem.

Engage
Prior to beginning the three conservation activities, have students list all the marine species that they consume. In small groups, allow them to brainstorm about the ways in which fishing could be harmful to the marine environment outside of these species.

Preparation
Prior to class, the instructor should collect the required materials and familiarize themselves with the goals and background information supplied for the activities. Also, it is recommended to set up each activity in different corners of the room to avoid congestion. Overfishing activity: collect all materials. Habitat destruction activity: set up tank with rock/sand and plants, set up jacks randomly in rocks, fill with water. By-catch activity: place fish in bucket.

Overfishing Activity: Version 1

Materials Needed

- Local nautical chart showing fishing grounds
- Pictures of fish species and fishing gear
- Pans or trays to hold "fish" (11" x 15" baking pans work well)
- About 15 goldfish crackers per pan
- About 10 colored goldfish crackers per pan blue ("bluefin tuna") are especially valuable
- Straws to use for catching fish
- Cups for collecting caught fish

Procedure

1. Divide students into groups so that two or three students are fishing from the same pan.
3. Distribute straws to students and have them cut end into spoon to pick up fish. Each student should have his or her own cup, placed a few paces away from the fishing grounds.
4. Tell the students the colored fish and especially blue fish are valuable. When you say "start fishing!" the students may fish for 10 seconds. Students must catch 1 blue, or 2 colored, or 5 regular goldfish to stay in the game.
5. Assess the populations of fish remaining in the pans. If at least one of a type of fish is left, it reproduces; add 1 fish for each one left.
6. Students may fish again for another two rounds. After three rounds, the price of red fish has gone down too far and they must be thrown back when caught.
7. Give students a minute to decide if they would like to regulate the fishery in any way. Students may decide to cooperate to catch enough fish, and both contribute to a single cup. They may also make agreements about how many or what types of fish to catch. If the other students don't agree to the rules, they don't have to follow them.
8. Allow students to fish again for another few rounds, then stop the fishing and wrap up. (The fish from the game have been handled and should not be eaten.)

Round #	# of fish at beg. of round	# of fish taken by 1st fisher	# of fish taken by 2nd fisher	# of fish taken by 3rd fisher	# of fish taken by 4th	fisher Total fish left at end of round
1						
2						
3						
Total	XXXX					XXXXXX

Discuss with students:

- What happened to the populations of different types of fish?
- What fish were removed from the population first?
- How successful were the fishermen in each round of fishing?
- What could be done to ensure that the fishermen catch enough to make a living, and the fish populations are not wiped out?

Overfishing Activity: Version 2

Procedure:
Play a game in which small groups of three to six students receive a plate of 20 goldfish crackers. In each group or "community" each player can go "fishing" in turn by taking 0–3 "fish". There should be no talking. Each player gets two turns.

For round two, replenish the stock in each fishery by doubling the number of fish remaining.
Repeat the procedure for a total of three "years" of two turns each. If any group has fished out all of their fish, they are done because the fishery has been wiped out. At the end of the three years, fill in the data table (below) for each group.

Once students have been able to observe that if people take fish too rapidly, the population is depleted, each group can play a different variation of the game (give each group a card with directions for a variation). Each group can play its variation for three years, with each player taking two turns per year. At the end of the three years complete the data table.

Group 1: Game with **Information** Provided
If people limit the number of fish they take, the fishery can keep up with the harvest rate, and in the long run there will be more fish. If they take fish too rapidly, they may get a lot of fish, but the population doesn't have time to replenish itself and may go to 0. Play again with no talking.

Group 2: Game with **Strategy** Provided
A good strategy for playing is for each person to take 1 or 2 fish most of the time. This will allow the population to last longer. But you are free to make your own choice. Play again with no talking.

Group 3: Game with **Communication and Cooperation**
Before you play again, talk together about how you are going to play the game. You may continue to talk during the game and decide together how many fish to take.

	Number fish remaining in the fishery	Number of fish caught per person (list each person's catch)	Number of fish caught per group
Group 1 After 3 years After 3 more years with information			
Group 2 After 3 years After 3 more years with strategy			
Group 3 After 3 years After 3 more years with communication			

By-Catch Activity

Materials Needed

- various small-sized plastic fish or goldfish crackers
- marine animals
- large bucket
- dixie cups

Procedure:

1. Each student receives a cup
2. A large bucket containing the fish is placed above the students' heads
3. Bucket should contain 20% target species compared to number of bycatch
4. Each student scoops out a cupful of plastic fish
5. One specific fish (target fish) will be valued at 5 points
6. The remaining species (by-catch) will be valued at -2 points
7. Determine final scores

Items for discussion or conclusion

1. Is the number of target species caught worth the price paid for the amount of by-catch?
2. Are there better ways to obtain target species than the ones represented in the activities?

Habitat Destruction Activity

Materials Needed

- fish
- aquarium
- plastic aquarium plants (50)
- different colored jacks (20)
- small fish nets
- sanded/rocky bottom

Procedure:

1. Each jack is considered a target species and is worth 10 points
2. Each student will get 2 minutes to grab as many jacks as possible with the fish nets
3. Each plant knocked over is valued at -5 points
4. Determine final scores

Items for discussion or conclusion

1. Is it possible to obtain the target species without disturbing the environment?

Adapted from:
<http://apcentral.collegeboard.com/apc/members/repository/ap03_apes_tragedy_stu_35071.pdf>
<http://marinediscovery.arizona.edu/lessons/gobies/Templates/index.html >
Instructions for Scales and Tails Activity by Pat Harcourt, Waquoit Bay Research Reserve and Melissa Sanderson, Cape Cod Commercial Hook Fishermens Association

III. Changes in Fishing Technology

Materials:

- Netting the Fish WS
    - Various size netting – onion bags, potato bags …
    - Various size dried beans – lima, red, navy …
    - large bins
- Let's Go Fishing WS
    - Sections of different types of fishing nets
    - Floats
    - Weights
    - Twine
    - Pieces of lumber
    - Pieces of steel
    - Heavy scissors
    - Pencils
    - Large needles
    - Paper

Inquiry Questions and Objectives:

1. What do you need to know to design own fishing gear to catch a target fish?
2. What would you need to build and test?
3. What works? What doesn't? Why?

Activities:

A. Target netting - Netting the Fish WS

B. Discuss designing own fishing gear - Let's Go Fishing WS

Netting the Fish

Objective:
Compare different sizes of netting to determine the ideal size for catch a target species of fish with as little by catch as possible.

Materials:

- Various size netting – onion bags, potato bags …
- Various size dried beans – lima, red, navy …
- large bins

Procedure:

1. KWL Chart – how many ways can we catch fish?
2. T Chart - discuss pros and cons of using a net for catching fish
3. Mix the beans into large bins – 1 per group
4. Have students predict which type of netting will catch the target "fish" (i.e. bean)
5. Have students experiment with the different netting, checking their predictions
6. Inquiry – have students try to identify how to catch each of the different types of fish (i.e. beans) with the least amount of by-catch

Let's Go Fishing

Grade K-12

Summary: Students will work in small groups to develop and try out fishing gear

Objective: Students will:

- Work in small groups
- Develop and try out gear of their own design
- Report their design and results of their efforts to the class

Skills: making models, cooperating in groups, designing new approaches, and oral communications

Materials:

- Sections of different types of fishing nets
- Floats
- Weights
- Twine
- Pieces of lumber
- Pieces of steel
- Heavy scissors
- Pencils
- Large needles
- Paper

Activity:

1. Have a brief discussion with the students assessing their knowledge of fishing with nets
2. Divide the class into learning groups of 3-4 students
3. Ask the students to design on paper then make fishing gear using the above list of materials
4. Take a visit to a lake, river, or ocean for the students to try out their designs
5. Back in the classroom, ask each group to discuss their fishing gear design and the successes/failures they encountered.

Outside Resources:

- Visit Winchester Fishing on Washington St. in Gloucester to watch the making of lobster traps.
- Invite local commercial fishermen into the classroom to discuss their methods of fishing
- Correspond with fishing gear researchers in Woods Hole

Extension:

- Develop a classification system for the types of fish caught
- Research the history of Massachusetts's commercial fishing gear
- Make and try out other types of fishing gear, such as native American fishing gear
- Develop different types of fishing gear for different types of fish
- Research the types of fish caught off of Massachusetts

Sources:
http://marinediscovery.arizona.edu/lessons/gobies/Templates/index.html

Tragedy of the Commons Simulation by Tori Haidinger, Teacher and Dean, St. Margaret's Episcopal School

http://treasures.amnh.org/pdfs/FishingCommunitySimulation.pdf

MITS Bibliography

The Cod's Tale by Mark Kurlansky

Cod: A Biography of the Fish That Changed the World by Mark Kurlansky

NOAH's Essential Fish Habitat descriptions: Cod, Haddock and Halibut
http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/GIS_inven.htm

North Atlantic Fish Populations Shifting
http://www.nefsc.noaa.gov/press_release/2009/SciSpot/SS0916/

Atlantic Fishing Methods
http://www.cdli.ca/cod/history6.htm

Schooner Adventure
Massachusetts Curriculum Frameworks Covered

Life Science (Biology) **Grades 3–5**	**Life Science (Biology)** **Grades 6–8**
3. Recognize (that plants and) animals go through predictable life cycles that include birth, growth, development, reproduction, and death. 5. Differentiate between observed characteristics (of plants and) animals that are fully inherited (e.g., color of flower, shape of leaves, color of eyes, number of appendages) and characteristics that are affected by the climate or environment (e.g., browning of leaves due to too much sun, language spoken). 6. Give examples of how inherited characteristics may change over time as adaptations to changes in the environment that enable organisms to survive, e.g., shape of beak or feet, placement of eyes on head, length of neck, shape of teeth, color. 7. Give examples of how changes in the environment (drought, cold) have caused some plants and animals to die or move to new locations (migration). 8. Describe how organisms meet some of their needs in an environment by using behaviors (patterns of activities) in response to information (stimuli) received from the environment. Recognize that some animal behaviors are instinctive (e.g., turtles burying their eggs), and others are learned (e.g., humans building fires for warmth, chimpanzees learning how to use tools).	8. Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms. 12. Relate the extinction of species to a mismatch of adaptation and the environment.
Technology/Engineering **Grades 3–5**	**Technology/Engineering** **Grades 6–8**
2. Engineering Design 2.1 Identify a problem that reflects the need for shelter, storage, or convenience. 2.2 Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists. 2.3 Identify relevant design features (e.g., size, shape, weight) for building a prototype of a solution to a given problem.	1.1 Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., strength, hardness, and flexibility). 2.3 Describe and explain the purpose of a given prototype.